Decommissioning Plan for the PRR1 Research Reactor in PNRI

- First draft -

Working group 2

Argentina, Serbia 1, Malaysia, Lybia 2, Philippines

Group chairman: Argentina

Basic assumptions:

1. Transition period will not be described in separate Transition Plan. Decommissioning Plan have to cover all the transition activities:
    a. Remaining fuel removal from the building
    b. Removal of operational waste
    c. Removal of radioactive sources storied in the building
    d. Removal of the liquids
2. According to the current knowledge, after completion of the decommissioning project reactor building will be used for non-nuclear laboratory purposes and research activities. Thus, final goal of the project is unrestricted use of the building and removal of all the reactor systems and components, both radioactive and non-radioactive, is required.
3. Clearance and release criteria are available.
4. Waste storage facilities for LLW are available and licensed with capacities to accept all generated RAW, waste packaging and acceptance criteria are known.
5. Due to limited waste storage capacities, waste minimization should be one of the basic project objectives.

1. Description of reactor, site and area – all the information for chapter 1 except radiological status are available in existing documents (Copy-Paste)

1.1. Site description
- 1.1.1. Location
- 1.1.2. Ownership
- 1.1.3. Geology
- 1.1.4. Hydrology
- 1.1.5. Climate
- 1.1.6. Population

1.2. Surrounding area
- 1.2.1. PNRI
- 1.2.2. Waste storage
- 1.2.3. Laboratories
- 1.2.4. University

1.3. Description of the reactor systems and components

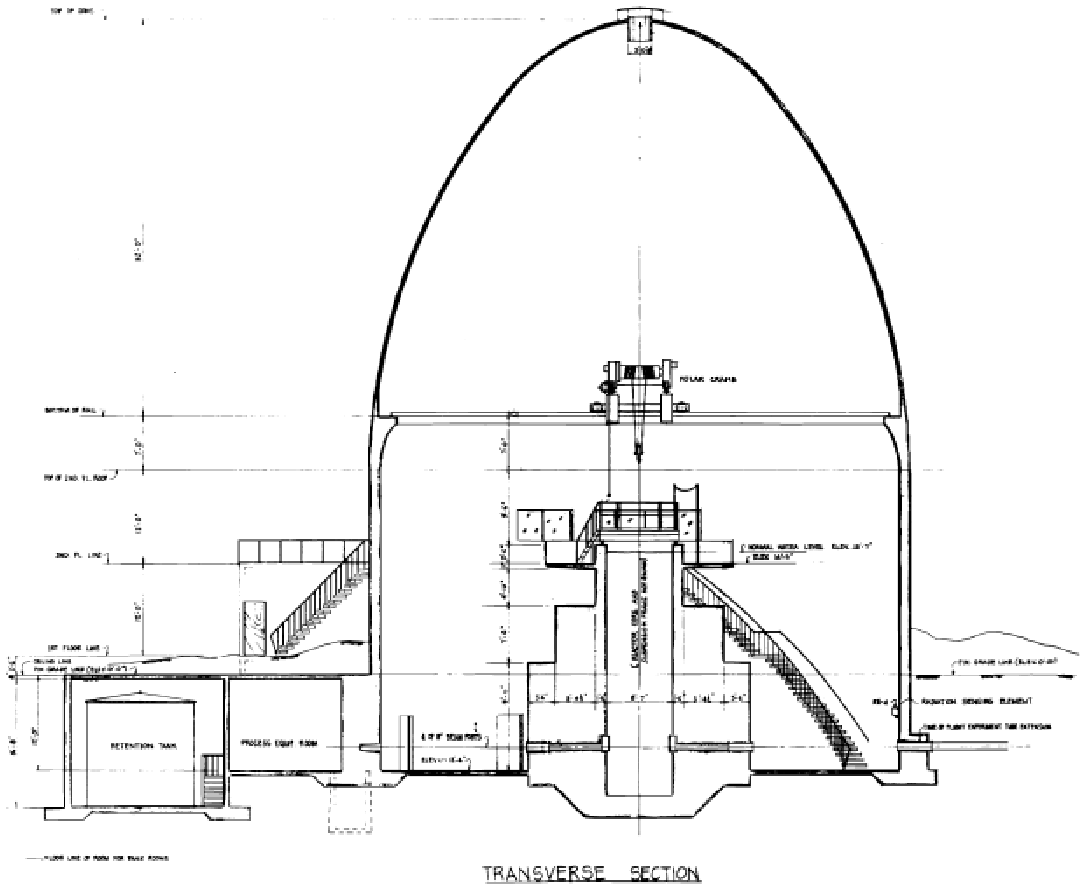

Figure X. Vertical cross section of the reactor building

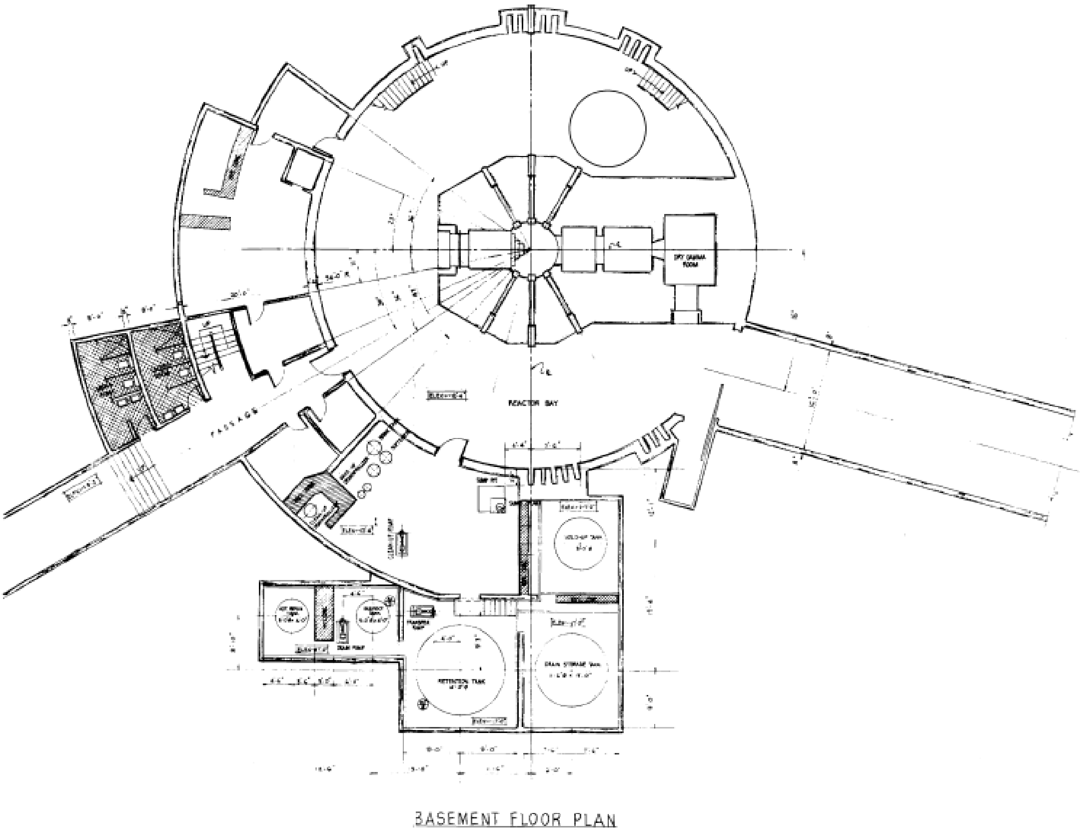

Figure X. Horizontal cross section of the reactor building basement floor

1.3.1. Active zone
1.3.2. Fuel
1.3.3. Supporting structures
1.3.4. Pool
1.3.5. Primary coolant system
1.3.6. Secondary coolant system
1.3.7. Auxiliary systems
1.3.8. Fuel handling system
1.3.9. Spent fuel storage
1.3.10. Radiological monitoring
1.3.11. Power supply
1.3.12. Water supply
1.3.13. Ventilation

1.4. Radiological status

1. The reactor has never had a fuel cladding failure, and except for one or two cases many years ago when irradiated capsules fell into the reactor pool, never had the pool water contaminated.

2. Known radioactive sources inside the reactor building:

   a. Two sets of Co-60 pencils, a legacy of the time when the reactor pool was used for gamma irradiation independently of reactor operation. One set had an activity of 20 kCi in 1970, and is in wet storage (in a submerged lead cask). The other set had an activity of 19 kCi in 1978, and is in dry storage inside an old shipping cask sitting on the reactor bay floor.

b. The remains of various irradiation rigs and small removable parts of the reactor core. most of these are in wet storage in the storage tank or in dry storage behind a small lead shield on the reactor platform. Notable exceptions are the core's control elements (still in the core box), a large rig for neutron irradiation of seeds (in the reactor bay), and some long irradiation tubes (in the pool platform area).

c. The remains of a neutron spectrometer on the reactor bay floor. There were actually two neutron spectrometers and a time-of-flight rig attached to three of the reactor's beam tubes, but the other two set-ups were moved to the waste storage area when the storage tank was constructed in the reactor bay to hold the nuclear fuel in the 1990's.

d. Graphite in the reactor's thermal column (not highly radioactive).

e. The inner and outer plugs of the six beam tubes (only slightly radioactive). The inner shutters of the beam tubes and their housings (more radioactive).

f. Ion-exchange resin in the reactor's clean-up demineralizer in the process equipment room.

g. The neutron-activated core box. The core box is made of high-purity aluminum and has low residual activity, but there are a few stainless-steel bolts in the structure and a small lead shield (for a neutron detector) that have higher activity.

h. Neutron activation products in the pool liner, in the concrete of the biological shield, in the beam tubes, in the thermal column casing and lead shield. These are mainly in the pool's high-power section, but the reactor core was also operated in the pool's low-power section (not frequently), where the core irradiated a small dry room embedded in the biological shield.

   There is a question of whether the pool liner leak that was the immediate cause of reactor shutdown in 1988 caused the migration of the activation products from the limited areas exposed to neutron radiation to throughout the biological shield. If so, the amount of contaminated concrete that may have to be removed could be orders of magnitude larger. It is known that leaking pool water percolated from 1988 to 1992 over the entire backside of the pool liner and through the seams between the pour stages of the concrete.

2. The following locations in the reactor building probably have some degree of radioactive contamination:

    a. Laboratory rooms in the basement floor used for radioisotope production and waste storage. These rooms were partially cleaned up in the late 1980s when a new I-131 production hot cell was installed. The reactor was shut down before the I-131 facility could be used.

    b. A laboratory room in the first floor that was used for NAA and some work with small amounts of radioactivity. The last use of the room was as the terminal for an automated DNAA (Delayed Neutron Activation Analysis) set-up that irradiated many geological samples in a search for uranium ore. The room undoubtedly still has traces of irradiated, powdered rock and sand.

    c. The process equipment room in the basement floor. This room contains the equipment for the reactor's water purification system and cooling system. This room also contains the sump pit, the collection area where all floor drains in the reactor bay terminate.

    d. The tank rooms in the basement floor. These rooms contain the reactor's N-16 delay tank, two large tanks for storing pool water and smaller tanks for storing waste water and waste ion-exchange resin.

    e. The mechanical/electrical equipment room in the first floor. This room contains electrical switchgear, an air compressor, and a turbo blower that formerly ran the reactor's pneumatic NAA system. A chiller for the air conditioning system of the reactor building is also located in the same room, but the air conditioning system was not in place when the reactor was still operational and is not likely to be contaminated.

3. The following are believed to be not contaminated:

    a. The entire west wing of the reactor building. The west wing was originally meant to house a large radioisotope production laboratory, but the necessary hot cells and other equipment were never installed. The space was used for offices and non-radioactive storage space, except for a small room where fresh fuel was stored. However, there probably was some air infiltration from the rest of the reactor building, and the west wing should not be exempted from a contamination survey.

    b. The reactor building ventilation system was removed in the 1990s. The old ducting, filters, blowers and other equipment no longer exist (sold for scrap after being cleared for contamination).

4. In addition to the obvious places, the following could have contamination and should be investigated:

    a. The septic tanks for the reactor building toilets and the ground around them. (The building is not connected to a sewerage system.)

b. The discharge pipe of the reactor building. The contents of the reactor building's sump pit was pumped to a single discharge pipe which ran underground to a water run-off channel beyond the PNRI fence about 100 meters away. The original pipe collapsed or was otherwise blocked in the 1980s, and a new pipe was laid then.

c. The interior of the piping embedded in the reactor's biological shield and under the floor of the reactor bay. These carried the primary coolant water of the reactor. The floor drain pipes also run under the reactor bay floor.

d. The interior of the piping in the process equipment room.

Detailed radiological status of the facility will be known after completion of the radiological characterization.

2. Life history and future site use– all the information for chapter 2 available in existing documents (Copy-Paste)

2.1. Commissioning

Copy from existing documents

2.2. Operation history

Copy from existing documents

2.3. Reasons for shutdown

The PRR-1 was last operated in 1988. Reactor was stopped in order to perform repair work on the poll.

2.4. Spent fuel repatriation

All the amounts of SNF have been shipped to USA. Remaining amount with very low burnup will be stored in the safe storage facility (to be defined) with the Co sources.

2.5. Unplanned events during operation or maintenance work

According to the best knowledge and information available, there were no accidents during the reactor operation or significant unplanned events during the surveillance and maintenance work performed. Only small spills in limited areas of the reactor room have been happened.

2.6. Reasons for decommissioning

Reactor was stopped in 1988. Decision for final shutdown and approach to decommissioning was made in 2005. Main reasons for decommissioning are financial (lack of funding), technical (difficulties to repair leakage from the reactor pool) and administrative (owner's request for use of the site in non-nuclear activities).

2.7. Plans for future site use

According to the current knowledge, after completion of the decommissioning project reactor building will be used for laboratory purposes and research activities. Thus, final goal of the project is unrestricted use of the building and removal of all the reactor systems and components, both radioactive and non-radioactive, is required.

3. Rationale for preferred decommissioning options

3.1. Project objective and final status

Project objective is unrestricted use of the building. Final status should be empty and radiologically clean building, without hazardous materials.

3.2. Criteria for strategy options study

The following set of criteria has been evaluated:

- National legislation and regulations,
- Safety (inventory of radionuclides, estimated exposures)
- Technology
- social impacts
- availability of waste management facilities
- availability of experienced and trained staff
- availability of funds
- cost

3.3. Evaluated options

Immediate dismantling
Deferred dismantling
Entombment

3.4. Details of the strategy options study

To be included later

3.5. Selected strategy and reasons for selection

Combination of immediate and deferred dismantling will be applied.
Explanation in more details.

4. Organization and staff capabilities

4.1. Staffing

4.1.1. Available staff

4.1.2. Experience

4.1.3. Organizational chart

4.1.4. Roles

4.1.5. Responsibilities

4.1.6. Lines of communication and reporting

4.1.7. Training

4.1.8. Contractors and stakeholders

4.2. Licensing process

4.2.1. Current license

4.2.2. Identification of the regulatory authorities

4.2.3. Regulatory requirements
4.2.4. Interactions with the regulatory authorities
4.2.5. Safety documentation required

5. QA Program

The quality assurance (QA) programme to be applied during decommissioning may be described in a separate document referenced and summarized in the decommissioning plan. The document in place during the facility's operation is generally valid for the decommissioning activities, except for revisions to the organizational structure and other minor changes. The QA topics that have to be elaborated are described below

5.1. Organization

Organizational chart, duties, responsibilities, lines of communication and reporting to be included

5.2. QA Programme
5.3. Training programme
5.4. Document control
5.5. Control of measuring and test equipment
5.6. Corrective actions
5.7. QA records
5.8. Audits and surveillance
5.9. Lessons learned programme

6. Waste Management including criteria for segregation and recycling

6.1. Waste types

Most of the radioactive waste generated during reactor decommissioning will be LLW. Transition waste will contain ILW (Co-60 sources are assumed to be waste also).

6.2. Waste streams
6.2.1. Solid waste
Reactor internals, control rods, primary coolant system components (piping, pump, heat exchanger), concrete, deionization system components, storage tank, graphite including aluminum casing, experimental channels (horizontal and vertical), control instrumentation from the core, materials and equipment stored around the reactor block, possible contamination of soil, contaminated personal protective equipment and tools.

6.2.2. Liquid waste
Water from the tank in the basement, secondary waste from decontamination, sludge from the septic tanks, sump sludge

6.2.3. Chemical hazardous, flammable and other hazardous waste

Asbestos - no, PBC - no, graphite - yes, oils – no, lead bricks and in paints, phenolic paint,

6.2.4. Waste containing both radiological and non-radiological hazardous materials

Grephite

6.2.5. Conventional waste

Majority of concrete structures, all components declared to be clean after radiological characterization

6.3. Estimation of waste amounts

6.3.1. Primary waste

Estimate for ASTRA reactor, Seibersdorf, Austria, pool type, 10 MWt, operation 1960-1999:

A preliminary evaluation of the expected amount of radioactive waste was performed which showed that it would amount to approximately 320 kg of intermediate-level waste (ILW), mainly elements of the reactor core, about 100 t of activated low-level waste (LLW), and about 60 t of contaminated LLW.

PRR-1, based on scaling: 10 m^3 of LLRW (contaminated concrete), 500 kg of contaminated stainless steel pipes (primary circuit), up to 100 kg of ILRW (reactor internals)
total 300 m^3 of concrete (real data), 290 m^3 expected to be clean (conventional waste or for reuse)

6.3.2. Secondary waste – to be added later by PNRI

Decontamination waste
Contaminated protective items
Conaminated tools

6.4. Identification of the radioactive waste treatment and storage/disposal facility

The only waste storage facility available in the country is PNRI's interim waste storage facility. The final disposal facility for LILRW is not available.
The expansion of the PNRI's interim waste storage facility and the construction of a fuel storage vault are essential supporting activities of the decommissioning effort.
The waste storage facility will have to seek an amendment of its authorization under the PNRI internal regulatory system in order to be allowed to receive the PRR-1 decommissioning waste. There will be a formal regulatory process, similar to the process the facility is now undergoing to be authorized to store the waste it already has.
The fuel storage vault will have to be similarly authorized. It is possible that the vault will be co-located in the waste storage facility for reasons of security, and its authorization may then be included in the amended authorization of the waste storage facility.

6.5. Waste acceptance criteria

Have to be provided by the waste storage/disposal facility

6.6. Waste segregation and packaging

Waste segregation procedure exists. Waste has to be segregated according to type of material (metal, concrete, plastic, textile), activity (half lives), chemical composition, RAW will be packaged in 200 l drums.

6.7. Release criteria

The Philippine criteria for releasing material from the PRR-1, and also for releasing the site itself from regulatory control, are not yet defined and need to be established. Developing those criteria will be the responsibility of the NRLSD.

6.8. Recycling or reuse of clean materials

As the reactor operation has been successful and without significant contamination spills, it is expected that majority of the structural materials and components will meet release criteria and can be reused or recycled.
The Philippine criteria for releasing material from the PRR-1, and also for releasing the site itself from regulatory control, are not yet defined and need to be established. Developing those criteria will be the responsibility of the NRLSD.

7. Cost Estimate and Funding Mechanisms

a. Cost Estimate

To be elaborated later

b. Funding

Funds for the PRR-1 decommissioning will be provided by the Government through the Management Budget Department on against short term activity plans 2 or 3 years).